

## GLOSSARY

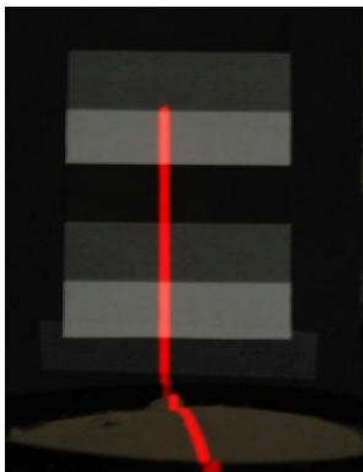
**Astronaut Memorial Foundation's Center for Space Education (CSE) Building M6-306** – located adjacent to the west end of the KSCVC. This is where the Slide Presentation and Demonstrations, RoboPits, Bot Shop, Judge's and Volunteer areas are located.

**Autonomous** – The operation of a team's mining robot with no human interaction.

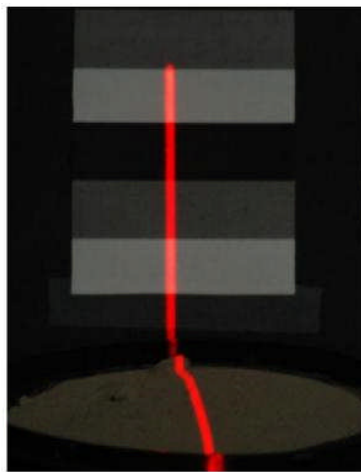
**Basaltic Regolith Properties** – Since the properties of Mars regolith vary and are not well known, this competition will assume that Martian basaltic regolith properties are similar to the Lunar regolith as stated in the "Lunar Sourcebook: A User's Guide to the Moon", edited by G. H. Heiken, D. T. Vaniman, and B. M. French, copyright 1991, Cambridge University Press.

[http://www.lpi.usra.edu/publications/books/lunar\\_sourcebook/](http://www.lpi.usra.edu/publications/books/lunar_sourcebook/)

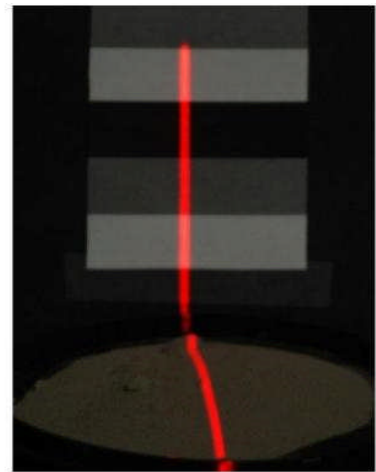
**Black Point-1 (BP-1) Reflectivity** – NASA performed tests to answer questions about BP-1 reflectivity for LIDAR (or other LASER-based) navigation systems. The laser is not a beam – it is spread out as a sheet that is oriented in the vertical direction, so it is draped across the BP-1 and across a white/gray/black target that is standing up behind the BP-1 in the images. The BP-1 is the mound at the bottom of each image. Teams can get the reflectivity of the BP-1 by comparing the brightness of the laser sheet seen reflected from the BP-1 with the brightness of the same sheet reflected from the white and black portions of the target. The three images are for the three angles of the laser. Note the BP-1 is mounded so they need to account for the fact that it is not a flat surface if they choose to analyze the brightness in the images. The three pictures below were shot with the camera at 10, 16, and 21 degrees relative to the surface. The laser was at an angle of 15 degrees. The camera speed and aperture were set to (manual mode): 1/8 s, f/4.5.



10 degree



16 degree



21 degree

**Black Point-1 (BP-1)** – The coefficient of friction and the cohesion of Martian soil have not been precisely measured due to a lack of scientific data from Mars. Instead, they have been estimated via a

variety of techniques. Both parameters (coefficient of friction and cohesion) are highly dependent on the compaction (bulk density, porosity) of the Martian soil.

- 1) It does not behave like sand.
- 2) There are naturally occurring rocks in the BP-1 aggregate.
- 3) The coefficient of friction has not been measured for BP-1.
- 4) Is a crushed lava basalt aggregate which is similar to Mars Volcanic Ash.
- 5) The density of the compacted BP-1 aggregate will be between 1.5 g/cm<sup>3</sup> and 1.8 g/cm<sup>3</sup>.
- 6) BP-1 behaves like a silty powder soil and most particles are under 100 microns in diameter.
- 7) Will be compacted and the top layer will be raked to a fluffy condition of approximately .75 g/cm<sup>3</sup>, similar to the Martian surface.
- 8) The study on BP-1 is available on <http://www.nasa.gov/nasarmc> "Soil Test Apparatus for Lunar Surfaces" .
- 9) Dr. Philip Metzger, NASA Physicist (ret) and current University of Central Florida faculty member, describes BP-1 and its behavior at <http://youtu.be/hMfrv7mlxbE>.
- 10) Teams are encouraged to develop or procure simulants based on basaltic minerals and lunar surface regolith particle size, shape, and distribution.
- 11) BP-1 is not commercially available and it is made from crushed basalt fines.

However, JSC-1A is available from Orbital Technologies at <http://www.orbitec.com/store/simulant.html>, and

NU-LHT is commercially available from Zybek Advanced Products (ZAP) at: <http://www.zybekap.com>.

**Caterpillar Mining Arena** – An open-topped container (i.e., a box with a bottom and 4 side walls), containing BP-1, within which the mining robot will perform each competition attempt. The inside dimensions of the each side of the Caterpillar Mining Arena will be 7.38 meters long and 3.88 meters wide, and 1 meter in depth. The BP-1 aggregate will be approximately .3 meters in depth and approximately .5 meters from the top of the walls to the surface. There is no guarantee that the BP-1 in the mining arena will have a level surface, since planetary surfaces are random and chaotic. Be prepared for slopes, irregularities and small rocks in the BP-1 simulant surface. The Caterpillar Mining Arena for the practice days and official competition will be provided by NASA. The Caterpillar Mining Arena will be outside in an enclosed tent. The Caterpillar Mining Arena lighting will consist of high intensity discharge (HID) lights such as metal halide lights inside a tent structure with clear sides, which is not quite as bright as outdoor daylight conditions. The atmosphere will be an air-conditioned tent without significant air currents and cooled to approximately 70 - 75 degrees Fahrenheit. See Diagrams 1 - 3. The Caterpillar Mining Arena steel, primer and paint specifications are as follows:

- 1) Steel: A-36(walls) & A-992(I-beams) structural steel.
- 2) Primer: Devran 201 epoxy primer, 2.0 to 3.0 mils, Dry Film Thickness (DFT).
- 3) Paint: Blue Devthane 379 polyurethane enamel, 2.0 to 3.0 mils, DFT (per coat).

**Collector Bin** – A Collector Bin in the Caterpillar Mining Arena for each competition attempt into which each team will deposit excavated BP-1. The Collector Bin will be large enough to accommodate each team's excavated BP-1. The Collector Bin will be stationary and located adjacent to the Caterpillar Mining Arena. See Diagram 3.

**Competition attempt** – The operation of a team's mining robot intended to meet all the requirements for winning the mining category by performing the functional task. The duration of each competition attempt is 10 minutes.

**Excavated mass** – Mass of the excavated BP-1 and/or gravel deposited to the Collector Bin by the team's mining robot during each competition attempt, measured in kilograms (kg) with official result recorded to the nearest one tenth of a kilogram (0.1 kg).

**Functional task** – The excavation of BP-1 and/or icy regolith simulant from the Caterpillar Mining Arena by the mining robot and deposit of BP-1 icy regolith simulant from the mining robot into the Collector Bin.

**Gravel** - This is intended to simulate icy-regolith buried on Mars. The gravel will be approximately 2 cm in diameter (minimum size) but will have random particle sizes larger than that also mixed into the gravel. The gravel may be mixed in with the BP-1 in small quantities, but the majority of the gravel will be on the approximately lower 30 cm of the mining area regolith depth only. The gravel will be made of a hard rock material, and will not have a specific color.

**Kennedy Space Center Visitor Complex** – located at the eastern terminus of Florida S.R. 405. The Competition Arenas are located in the Rocket Garden, the practice Sand Box is located under NASA Central and the Awards Ceremony is held here on Friday evening.

**Mining robot** – A tele-operated or autonomous robotic excavator in the Robotic Mining Competition including mechanical and electrical equipment, batteries, gases, fluids and consumables delivered by a team to compete in the competition.

**Mining points** – Points earned from the two competition attempts in the Robotic Mining Competition will be averaged to determine ranking in the on-site mining category.

**Practice time** – Teams will be allowed to practice with their mining robots in the Caterpillar Mining Arena. NASA technical experts will offer feedback on real-time networking performance during practice attempt. Every team will get one practice run on a first come, first served basis. A maximum of two practice attempts may be allowed, but is not guaranteed and will be on a case by case basis.

**Reference point** – A fixed location signified by an arrow showing the forward direction on the mining robot that will serve to verify the starting orientation of the mining robot within the Caterpillar Mining Arena.

**Telerobotic** – Communication with and control of the mining robot during each competition attempt must be performed solely through the provided communications link which is required to have a total average bandwidth of no more than 5.0 megabits/second on all data and video sent to and received from the mining robot.

**Time Limit** – 5 minutes to set up the mining robot in the Caterpillar Mining Arena and 10 minutes for the mining robot to perform the functional task. Safe the robot and remove from the mining arena quickly and as directed by the mining judge.